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Furusawa

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(54) **MEDIUM DISCHARGE DEVICE AND IMAGE FORMING APPARATUS**

(71) Applicant: **Oki Data Corporation**, Tokyo (JP)

(72) Inventor: **Yasunori Furusawa**, Tokyo (JP)

(73) Assignee: **OKI DATA CORPORATION**, Tokyo (JP)

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B65H 29/12 (2006.01)
G03G 15/00 (2006.01)

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CPC ***B65H 29/125*** (2013.01); ***B65H 29/52*** (2013.01); ***B65H 29/70*** (2013.01); ***G03G 15/6552*** (2013.01)

(58) **Field of Classification Search**
CPC B65H 29/70; B65H 29/52
USPC 271/188, 209
See application file for complete search history.

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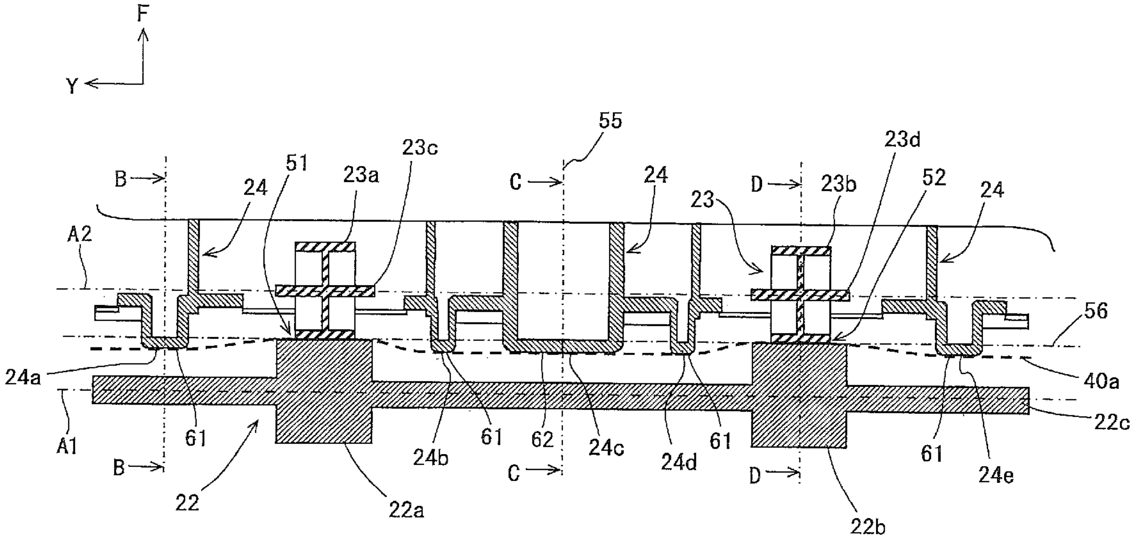
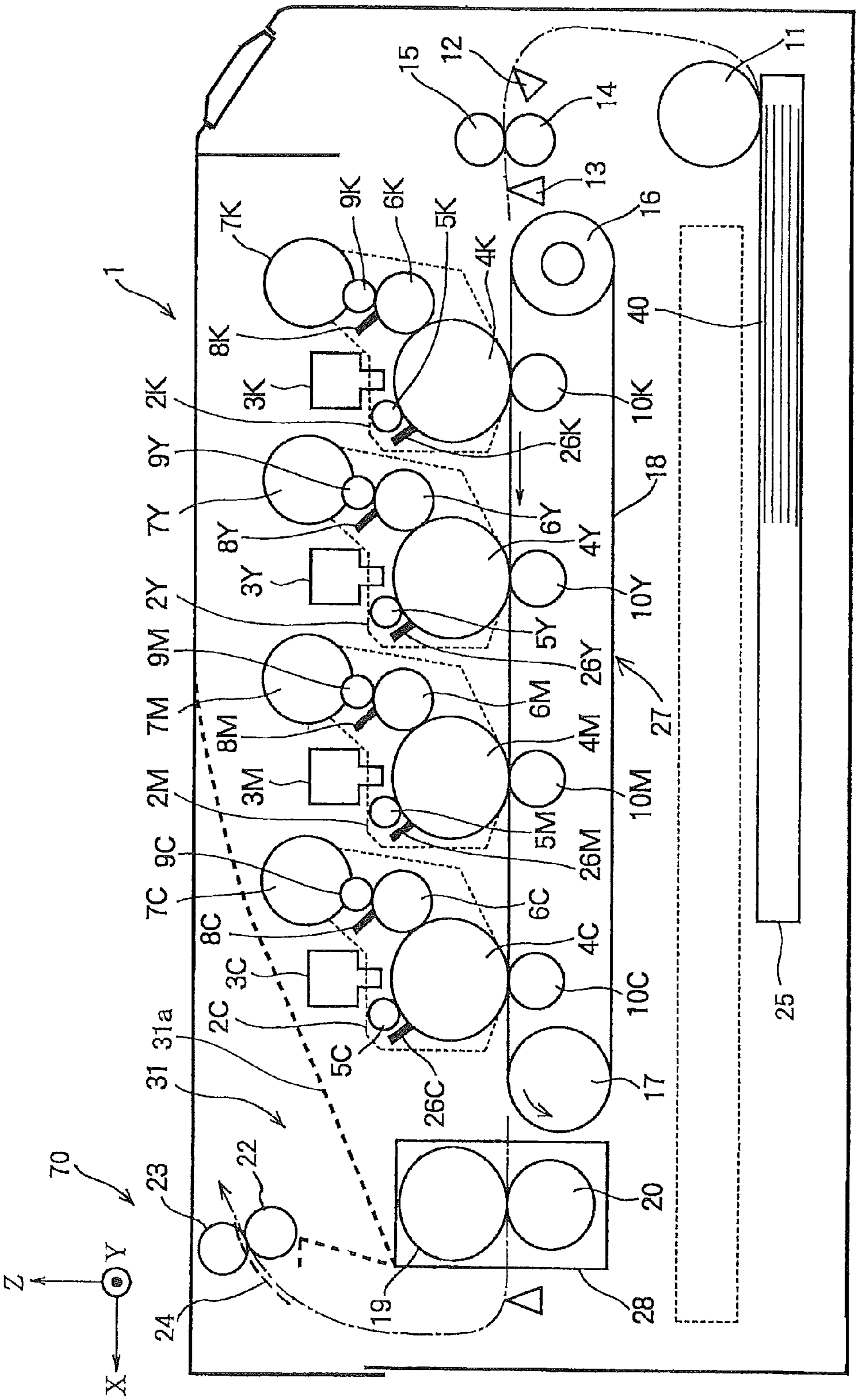
Primary Examiner — Luis A Gonzalez
(74) *Attorney, Agent, or Firm* — Rabin & Berdo, P.C.

(57) **ABSTRACT**

A medium discharge device includes: a discharge tray having a placing surface on which a medium is to be placed; a first pair of discharge rollers configured to rotate about axes to discharge the medium through a first nip onto the discharge tray; a second pair of discharge rollers configured to rotate about the axes to discharge the medium through a second nip onto the discharge tray; and a discharge guide for guiding the discharged medium. The discharge guide includes a first projection between the first and second pairs of discharge rollers, and a second projection on an opposite side of the first projection with respect to the first pair of discharge rollers. Each of the first and second projections projects to the placing surface side relative to the first and second nips and has a guide surface opposite to the placing surface.

21 Claims, 8 Drawing Sheets

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7Y
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8M
9M
10M
26M
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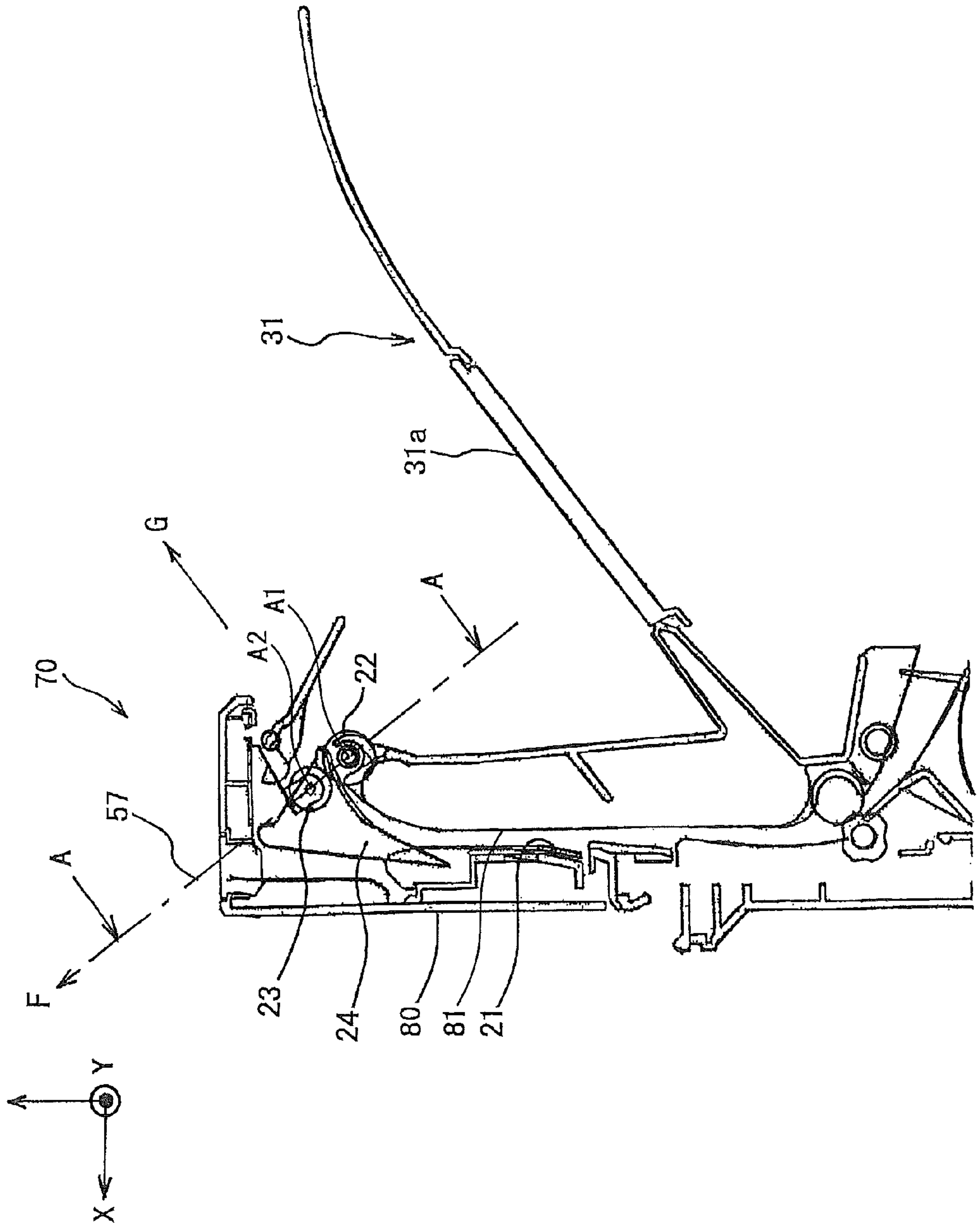
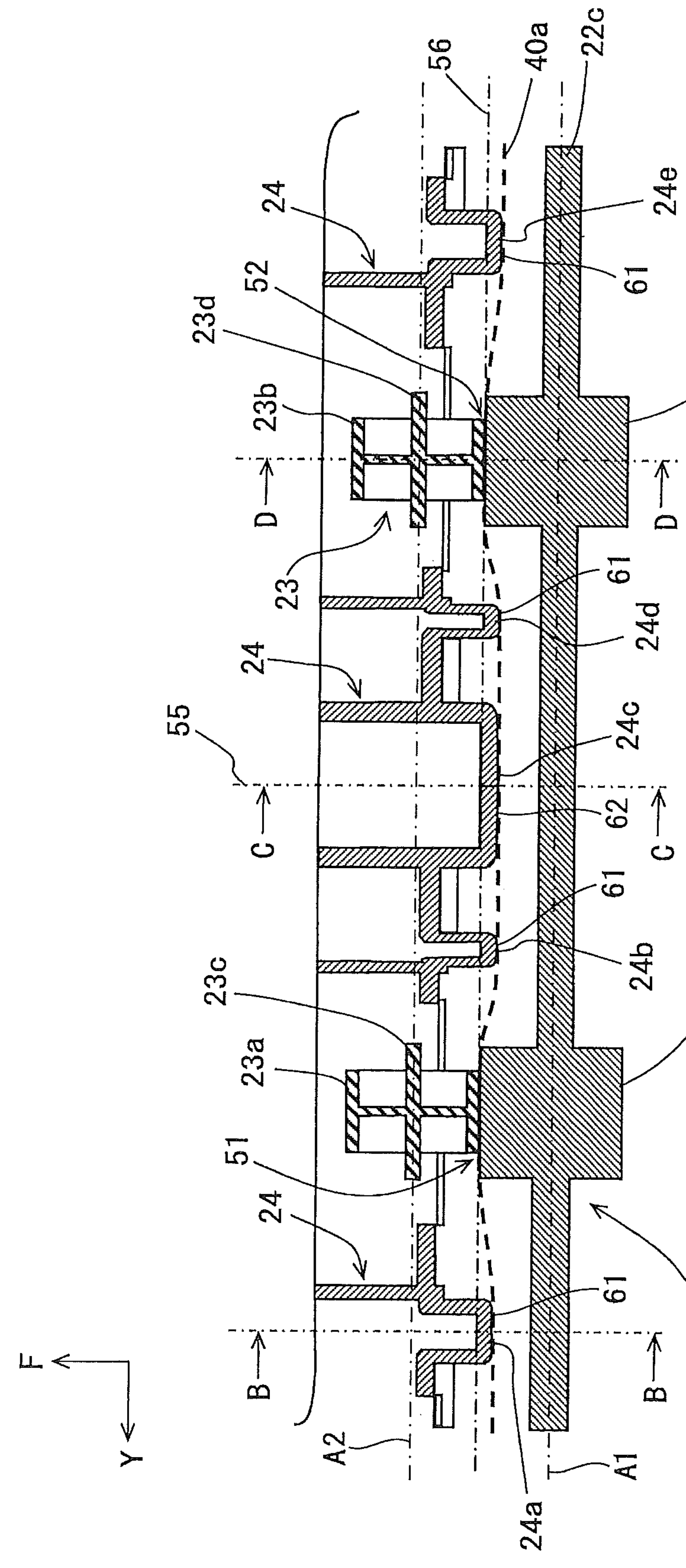
Y
X

FIG. 1

FIG.2

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C
62
61
24b
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24
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F
Y
A2
A1
24a

FIG.3

FIG.4

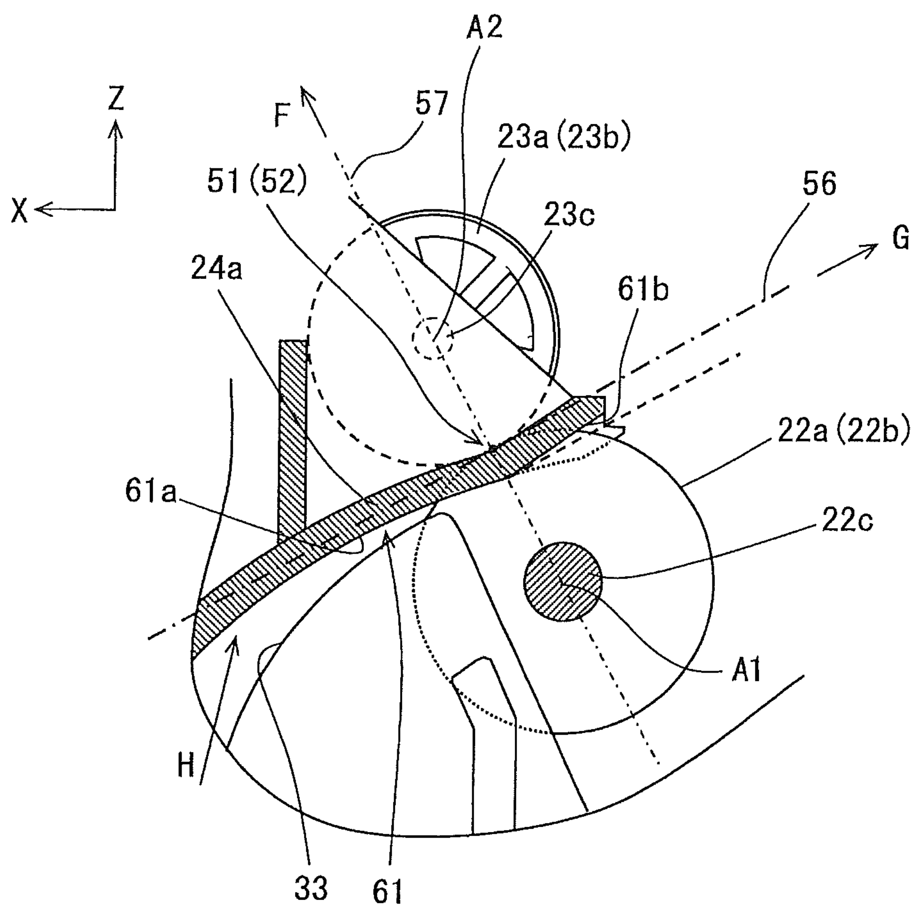
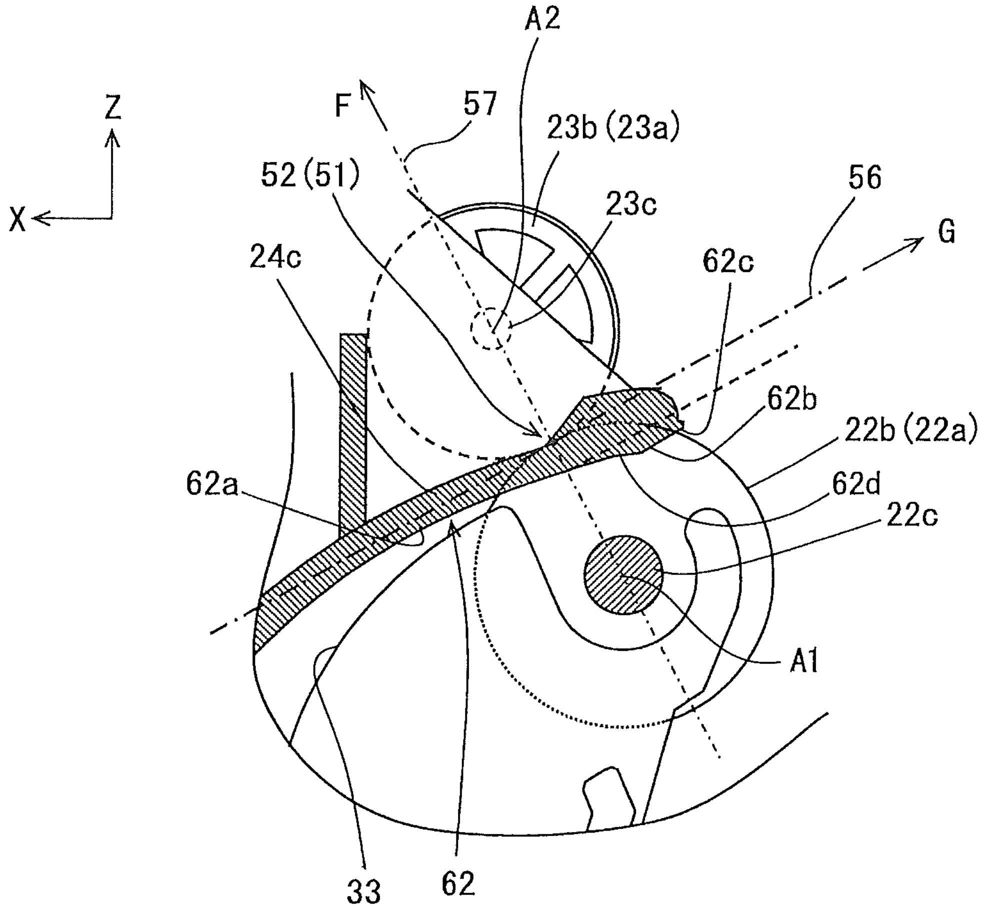


FIG.5



A2
F
57
23b (23a)
Z
X
52 (51)
23c
56
G
24c
62c
62b
22b (22a)
62a
62d
22c
A1
33
62

FIG.6

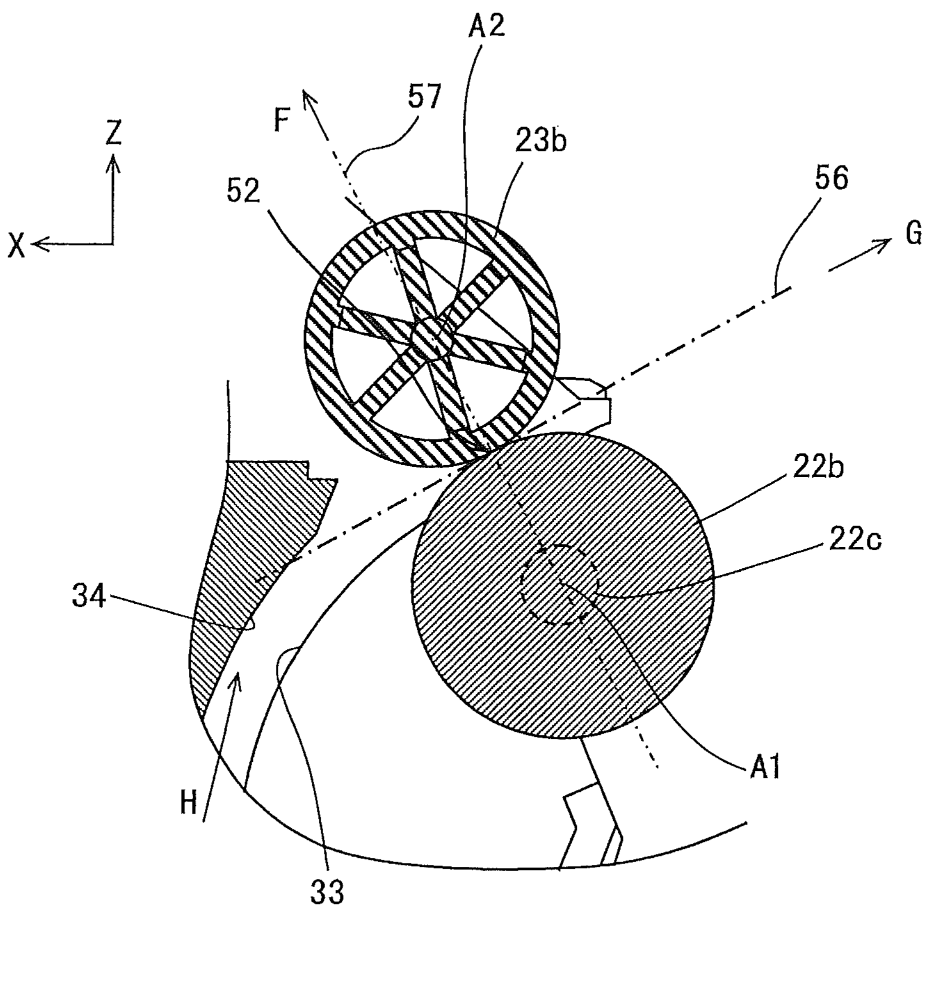
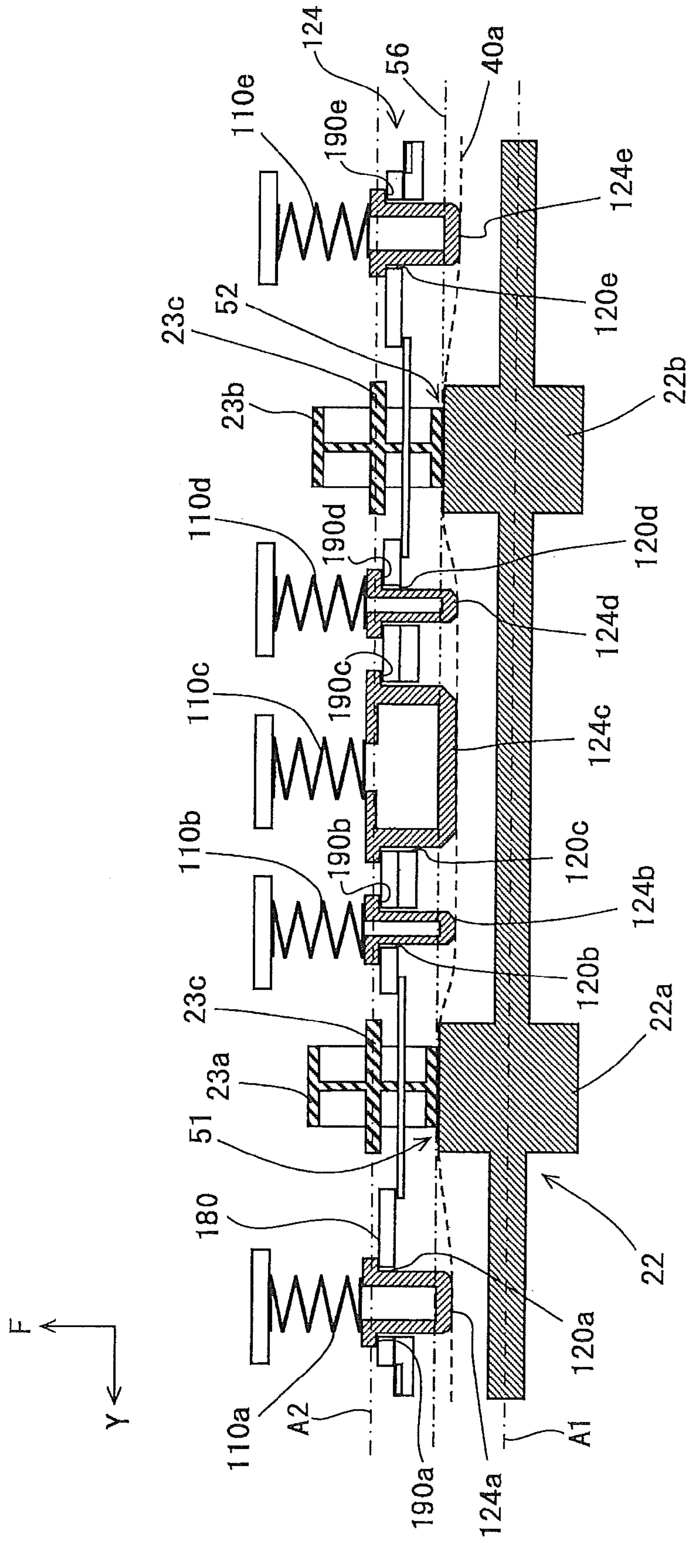


FIG.7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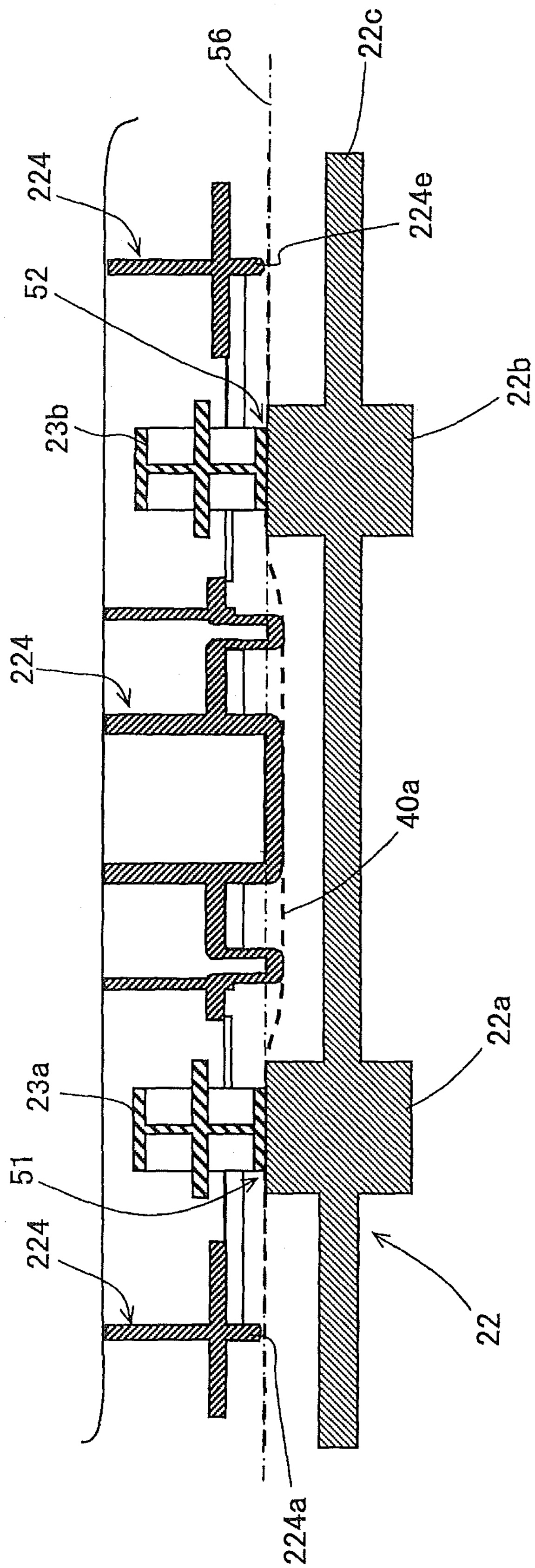
124c
120c
110b
190b
124b
120b
23c
23a
22a
51
180
22
120a
110a
A2
190a
124a
A1
F
Y

FIG.8



MEDIUM DISCHARGE DEVICE AND IMAGE FORMING APPARATUS

BACKGROUND OF THE INVENTION

1. Field of the Invention

The present invention relates to a medium discharge device for discharging a medium, such as a recording medium after printing, outside an apparatus, and an image forming apparatus including the medium discharge device.

2. Description of the Related Art

A general image forming apparatus, such as a copier, a facsimile machine, and a scanner, includes a conveying path on which recording media are conveyed, discharge rollers for discharging the recording media outside the image forming apparatus, and a stacker on which the discharged recording media are stacked (for example, see Japanese Patent Application Publication No. 2012-93648).

As the number of recording media stackable on the stacker increases, the distance from the discharge rollers to the stacker increases, and the possibility of improper stacking due to sagging of the leading edge of the recording medium during discharge increases.

SUMMARY OF THE INVENTION

An aspect of the present invention is intended to reduce the occurrence of improper-discharge of a medium.

According to an aspect of the present invention, there is provided a medium discharge device including: a discharge tray having a placing surface on which a medium is to be placed; a first pair of discharge rollers configured to form a first nip between the first pair of discharge rollers, and rotate about respective axes parallel to each other to discharge the medium through the first nip in a discharging direction onto the discharge tray; a second pair of discharge rollers configured to form a second nip between the second pair of discharge rollers, and rotate about the respective axes to discharge the medium through the second nip in the discharging direction onto the discharge tray; and a discharge guide for guiding the medium discharged by the first pair of discharge rollers and the second pair of discharge rollers. The discharge guide includes: a first projection disposed between the first pair of discharge rollers and the second pair of discharge rollers in an axial direction parallel to the axes, the first projection projecting to the placing surface side relative to the first and second nips and having a first guide surface opposite to the placing surface; and a second projection disposed on an opposite side of the first projection with respect to the first pair of discharge rollers in the axial direction, the second projection projecting to the placing surface side relative to the first and second nips and having a second guide surface opposite to the placing surface.

According to an another aspect of the present invention there is provided an image forming apparatus including the above described medium discharge device.

Further scope of applicability of the present invention will become apparent from the detailed description given hereinafter. However, it should be understood that the detailed description and specific embodiments, while indicating preferred embodiments of the invention, are given by way of illustration only, since various changes and modifications within the spirit and scope of the invention will become apparent to those skilled in the art from this detailed description.

BRIEF DESCRIPTION OF THE DRAWINGS

In the attached drawings:

FIG. **1** is a schematic view showing a configuration of an image forming apparatus including a medium discharge device in a first embodiment of the invention;

FIG. **2** is an enlarged partial sectional view showing the medium discharge device in FIG. **1**;

FIG. **3** is a main part sectional view along line A-A in FIG. **2**;

FIG. **4** is a sectional view along line B-B in FIG. **3**;

FIG. **5** is a sectional view along line C-C in FIG. **3**;

FIG. **6** is a sectional view along line D-D in FIG. **3**;

FIG. **7** is a main part sectional view of a medium discharge device in a second embodiment of the invention; and

FIG. **8** is a sectional view of a medium discharge device as a comparative example.

DETAILED DESCRIPTION OF THE INVENTION

Embodiments of the invention will now be described with reference to the attached drawings.

First Embodiment

FIG. **1** is a schematic view showing a configuration of an image forming apparatus **1** including a medium discharge device in the first embodiment.

As shown in FIG. **1**, the image forming apparatus **1** includes four image forming units **2**K, **2**Y, **2**M, and **2**C, a transfer unit **27**, a sheet cassette **25**, a sheet feeding roller **11**, an entrance sensor **12**, a writing sensor **13**, conveying rollers **14** and **15**, a fixing unit **28**, and a medium discharge device **70**.

The image forming units **2**K, **2**Y, **2**M, and **2**C form toner images of black (K), yellow (Y), magenta (M), and cyan (C), respectively. So, the image forming units **2**K, **2**Y, **2**M, and **2**C include LED heads **3**K, **3**Y, **3**M, and **3**C, photosensitive drums **4**K, **4**Y, **4**M, and **4**C, charging-rollers **5**K, **5**Y, **5**M, and **5**C, developing rollers **6**K, **6**Y, **6**M, and **6**C, toner tanks **7**K, **7**Y, **7**M, and **7**C, developing blades **8**K, **8**Y, **8**M, and **8**C, and toner supplying sponge rollers. **9**K, **9**Y, **9**M, and **9**C, respectively.

The sheet cassette **25** stores recording sheets (e.g., sheets of paper) **40** as media. The sheet feeding roller **11** picks up and feeds the recording sheets **40** one by one from the sheet cassette **25** into a conveying path by cooperating with a separation member (not shown). The conveying rollers **14** and **15** conveys the fed recording sheet **40** to the transfer unit **27**. The transfer unit **27** includes an endless conveying belt **18**, a belt driven roller **16**, a belt driving roller **17**, and transfer rollers **10**K, **10**Y, **10**M, and **100**. The conveying belt **18** conveys the recording sheet **40** from the conveying rollers **14** and **15**. The transfer rollers **10**K, **10**Y, **10**M, and **100** transfer the toner images from the image forming unit **2**K, **2**Y, **2**M, and **2**C to the recording sheet **40** conveyed on the conveying belt **18**, respectively. The fixing unit **28** applies heat and pressure to the recording sheet **40** with the toner images transferred thereon to fix the toner images to the recording sheet **40**. The fixing unit **28** includes a fixing roller **19** having a heater such as a halogen lamp therein and a fixing backup roller **20**. The medium discharge device **70** includes a first discharge roller **22**, a second discharge roller **23**, a discharge guide **24**, and a discharge tray **31**. The first and second discharge rollers **22** and **23** discharge the recording sheet, **40** after the fixing. The discharge guide **24** guides the recording sheet **40** discharged by the first and second discharge rollers **22** and **23**. The discharge tray **31** stacks the recording sheet **40** discharged by the first and second discharge rollers **22** and **23**. The discharge tray **31** has a placing surface **31***a* on which the recording sheet **40** is placed.

In the image forming apparatus **1**, the recording sheet **40** is conveyed on the conveying path in a conveying direction. The image forming apparatus **1** further includes motors for rotating the rollers and other rotating members, rollers disposed on the conveying path at intervals not longer than a length of a minimum recording sheet in the conveying direction, a solenoid for switching the conveying path, or the like, which are not shown in FIG. **1**. The motors includes a sheet feeding motor for mainly rotating the sheet feeding roller **11**, a conveying motor for rotating the conveying rollers **14** and **15**, a conveying belt motor for rotating the belt driving roller **17**, a fixing motor for rotating the fixing roller **19**, the fixing backup roller **20**, and the discharge rollers **22** and **23**, image forming motors for individually rotationally driving the image forming units 2K, 2Y, 2M, and 2C, and the like.

In FIG. **1**, the X-axis represents a direction in which the recording sheet **40** is conveyed when passing through the image forming units 2K, 2Y, 2M, and 2C, the Y-axis represents a direction parallel to axes of rotation of the photosensitive drums 4K, 4Y, 4M, and 4C, and the Z-axis represents a direction perpendicular to both the X-axis and the Y-axis. The same applies to FIGS. **2** to **7**. Here, the image forming apparatus **1** is set so that the Z-axis is directed in a substantially vertical direction.

Next, a configuration of the medium discharge device **70** will be described with reference to FIGS. **2** to **6**.

FIG. **2** is an enlarged partial sectional view showing the medium discharge device **70** in FIG. **1**. FIG. **3** is a main part sectional view along line A-A in FIG. **2**. FIG. **4** is a sectional view along line B-B in FIG. **3**. FIG. **5** is a sectional view along line C-C in FIG. **3**. FIG. **6** is a sectional view along line D-D in FIG. **3**.

As shown in FIG. **2**, the first discharge roller **22**, the second discharge roller **23**, the discharge guide **24**, and the discharge tray **31** are attached to a main body **80** of the image forming apparatus **1**. The main body **80** has a guide portion **81** for guiding the recording sheet **40** from the fixing unit **28**. The first discharge roller **22** has an axis of rotation A**1** (referred to below simply as the axis A**1**) parallel to the Y-axis. The second discharge roller **23** has an axis of rotation A**2** (referred to below simply as the axis A**2**) parallel to the Y-axis. As described later, the first discharge roller **22** and the second discharge roller **23** are disposed to form nips between their peripheral surfaces. The first discharge roller **22** and the second discharge roller **23** discharge the recording sheet **40** in a discharging direction (indicated by arrow G in FIG. **2**), which is perpendicular to a virtual line **57** (indicated by the dashed-dotted line in FIG. **2**) perpendicularly intersecting the axes A**1** and A**2**. The discharging direction (i.e., the direction of arrow G) is directed obliquely upward. Here, the first discharge roller **22** is disposed below the second discharge roller **23** and on a discharge side (or the discharge tray **31** side) of the second discharge roller **23** in a horizontal direction.

As shown in FIG. **3**, the second discharge roller **23** includes a pair of roller portions **23***a* and **23***b* having the same shape. The roller portions **23***a* and **23***b* are disposed rotatably about the axis A**2** at a predetermined interval. The roller portions **23***a* and **23***b* respectively have shafts **23***c* and **23***d* on the same axis A**2**. The first discharge roller **22** has a shaft **22***c* parallel to the shafts **23***c* and **23***d* of the second discharge roller **23**, and a pair of roller portions **22***a* and **22***b* formed on the shaft **22***c* so as to face the pair of roller portions **23***a* and **23***b* of the second discharge roller **23**. The roller portions **22***a* and **22***b* have the same shape, and are slightly wider than the roller portions **23***a* and **23***b* in the Y-axis direction, respectively. The roller portions **22***a* and **23***a* form a nip **51** at a roller facing portion at which the roller portions **22***a* and **23***a* face each other. The roller portions **22***b* and **23***b* form a nip **52** at a roller facing portion at which the roller portions **22***b* and **23***b* face each other.

Here, the first discharge roller **22** receives rotational force to rotate in a direction for discharging the recording sheet **40**, and the pair of roller portions **23***a* and **23***b* of the second discharge roller **23** are rotated by the rotation of the first discharge roller **22** by friction with the first discharge roller **22** either directly or via the recording sheet **40**. That is, the first discharge roller **22** is a driving roller and the second discharge roller **23** is a driven roller. The roller portions **22***a* and **23***a* constitute a first pair of discharge rollers, which are configured to form a nip **51** therebetween and rotate about axes A**1** and A**2** to discharge the recording sheet **40** through the nip **51** onto the discharge tray **31**. The roller portions **22***b* and **23***b* constitute a second pair of discharge rollers, which are configured to form a nip **52** therebetween and rotate about axes A**1** and A**2** to discharge the recording sheet **40** through the nip **52** onto the discharge tray **31**. The first pair of discharge rollers and the second pair of discharge rollers rotate together about respective axes A**1** and A**2** to discharge the recording sheet **40** through the nips **51** and **52** respectively onto the discharge tray **31**. The first pair of discharge rollers and the second pair of discharge rollers are at positions different from each other in the direction of the axes A**1** and A**2**, and define a discharge plane **56** (indicated by the dashed-dotted line in FIG. **3**) passing through the nips **51** and **52** and being perpendicular to the virtual line **57** extending along the direction of arrow F.

The discharge guide **24** includes a plurality of projections: a projection **24***a* as a second projection, a projection **24***b* as a fourth projection, a projection **24***c* as a first projection, a projection **24***d* as a fifth projection, and a projection **24***e* as a third projection. The projections **24***a* to **24***e* are arranged in the Y-axis direction. Each of the projections **24***a* to **24***e* projects to the placing surface **31***a* side relative to the nips **51** and **52**. Specifically, each of the projections **24***a* to **24***e* projects from an opposite side of the placing surface **31***a* to the placing surface **31***a* side relative to the nips **51** and **52** through the discharge plane **56**. Each of the projections **24***a*, **24***b*, **24***d*, and **24***e* has a guide surface **61** opposite to the placing surface **31***a*, and the projection **24***c* has a guide surface **62** opposite to the placing surface **31***a*. Each of the guide surfaces **61** and **62** is located at the placing surface **31***a* side end of the corresponding projection. Although FIG. **3** illustrates the discharge guide **24** as comprising three separate parts, the discharge guide **24** is actually formed integrally.

The projection **24***c* is disposed between the roller portion **22***a* (or the first pair of discharge rollers) and the roller portion **22***b* (or the second pair of discharge rollers) in the Y-axis direction (referred to also as the axial direction) parallel to the axes A**1** and A**2**. The projection **24***a* is disposed on an opposite side of the projection **24***c* with respect to the roller portion **22***a* (or the first pair of discharge rollers) in the Y-axis direction. The projection **24***e* is disposed on an opposite side of the projection **24***c* with respect to the roller portion **22***b* (or the second pair of discharge rollers) in the Y-axis direction. The projection **24***b* is disposed between the projection **24***c* and the roller portion **22***a* (or the first pair of discharge rollers) in the Y-axis direction. The projection **24***d* is disposed between the projection **24***c* and the roller portion **22***b* (or the second pair of discharge rollers) in the Y-axis direction. Specifically, the projections **24***a* to **24***e* are formed plane-symmetrically with respect to a virtual center plane **55** perpendicular to the Y-axis and passing through the center between the nips **51** and **52**. In the Y-axis direction, the projections **24***a* to **24***e* are configured as follows: the projection **24***c* is located at the center portion and wider than the other projections **24***a*, **24***b*, **24***d*, and **24***e*; the projections **24***b* and **24***d* are located on the both sides of the projection **24***c* and have the same width narrower than that of the projection **24***c*; the projection **24***a* is located on the outer side of the projection **24***b* across the nip **51**; the projection **24***e* is located on the outer side of the projection **24***d* across the nip **52**; and the projections **24***a* and **24***e* have the same width narrower than that of the projection **24***c* and wider than those of the projections **24***b* and **24***d*.

The projections **24***a*, **24***b*, **24***d*, and **24***e* have the same shape when viewed from the Y-axis direction. Thus, the shape of the projection **24***a* will now be representatively described with reference to FIG. **4** showing the cross-section of the projection **24***a*.

In FIG. **4**, the dashed-dotted line in the direction of arrow F indicates the virtual line **57** perpendicularly intersecting the axis A**1** of the first discharge roller **22** and the axis A**2** of the second discharge roller **23**. The dashed-dotted line in the direction of arrow G indicates the discharge plane **56** perpendicular to the virtual line **57** and passing through the nips **51** and **52**. The first discharge roller **22** and the second discharge roller **23** convey and discharge the recording sheet **40** along the discharge plane **56** in the direction of arrow G (i.e., the discharging direction) in the nips **51** and **52**. The guide surface **61** extends from an upstream side to a downstream side of the nip **51** in the discharging direction, and includes an inlet surface **61***a* located upstream of the nip **51** and an outlet surface **61***b* located downstream of the nip **51**. The guide portion **81** of the main body **80** (see FIG. **2**) has a guide surface **33** below the guide surface **61**. On the upstream side of and in the vicinity of the nip **51** in the conveying direction, the guide surface **61** and the guide surface **33** in combination form the conveying path. The projection **24***a* receives the recording sheet **40** conveyed from below in a direction indicated by arrow H, and guides the leading edge of the conveyed recording sheet **40** along the conveying path toward the nip **51**.

As shown in FIG. **4**, when viewed from the Y-axis direction, the inlet surface **61***a* is disposed generally along and slightly below the discharge plane **56** (on the roller portion **22***a* side). The inlet surface **61***a* curves so as to separate from the discharge plane **56** as approaching the nip **51**, and projects downward (to the roller portion **22***a* side) from the nip **51** by a predetermined amount on the virtual line **57**.

On the downstream side of the nip **51**, the guide surface **61** is inclined to the discharge plane **56** so as to approach the discharge plane **56** downstream in the discharging direction, or parallel to the discharge plane **56**. In the example of FIG. **4**, the outlet surface **61***b* is formed continuously to the inlet surface **61***a*, and extends to slightly approach the discharge plane **56** as separating from the nip **51**. The outlet surface **61***b* may be parallel to the discharge plane **56**. The angle formed between the outlet surface **61***b* and the discharge plane **56** is preferably 0° to 10°. The same applies to the projections **24***b*, **24***d*, and **24***e*. Thus, each of the projections **24***b*, **24***d*, and **24***e* has the guide surface **61** and a positional relationship between the guide surface **61** and the discharge plane **56**, in the same manner as the projection **24***a*.

Next, the shape of the projection **24***c* will be described with reference to FIG. **5** showing the cross-section of the projection **24***c*.

In FIG. **5**, the dashed-dotted line in the direction of arrow F indicates the virtual line **57**, and the dashed-dotted line in the direction of arrow G indicates the discharge plane **56**. The guide surface **62** extends from the upstream side to the downstream side of the nip **52** in the discharging direction, and includes an inlet surface **62***a* located upstream of the nip **52** and an outlet surface **62***b* located downstream of the nip **52**. On the upstream side of and in the vicinity of the nip **52** in the conveying direction, the guide surface **62** forms the conveying path with the guide surface **33** disposed below the guide surface **62**. The projection **24***c* receives the recording sheet **40** conveyed from below in the direction of arrow H, and guides the leading edge of the conveyed recording sheet **40** along the conveying path toward the nips **51** and **52**.

As shown in FIG. **5**, when viewed from the Y-axis direction, the inlet surface **62***a* is disposed generally along and slightly below the discharge plane **56** (on the roller portion **22***b* side). The inlet surface **62***a* curves so as to separate from the discharge plane **56** as approaching the nip **52**, and projects downward (to the roller portion **22***b* side) from the nip **52** by a predetermined amount on the virtual line **57**. That is, in this embodiment, on the upstream side of the nip **52**, the inlet surface **62***a* of the guide surface **62** of the projection **24***c* is formed in the same manner as the inlet surface **61***a* of the guide surface **61** of the projection **24***a*.

On the downstream side of the nip **52**, the guide surface **62** has an inclined area **62***d* inclined with respect to the discharge plane **56** so as to separate from the discharge plane **56** downstream in the discharging direction. In the example of FIG. **5**, the outlet surface **62***b* is formed continuously to the inlet surface **62***a* and has the inclined area **62***d*. The inclined area **62***d* is formed continuously to the inlet surface **62***a* and curves so as to separate from the discharge plane **56** as it extends downstream in the discharging direction. Further, the outlet surface **62***b* has an end area **62***c* formed continuously to the inclined area **62***d* so as to extend parallel to the discharge plane **56**. Thus, the outlet surface **62***b* further projects downward (to the roller portion **22***b* side) relative to the position on the virtual line **57**.

As shown in FIGS. **4** and **5**, a difference between a projecting amount by which the projection **24***c* projects to the placing surface **31***a* side relative to the nip **51** and a projecting amount by which the projection **24***a* projects to the placing surface **31***a* side relative to the nip **51** increases downstream from the nip **51** in the discharging direction. The projecting amount of the projection **24***c* is, for example, defined as a distance from the discharge plane **56** to the guide surface **62** in the direction of the virtual line **57**. The projecting amount of the projection **24***a* is, for example, defined as a distance from the discharge plane **56** to the guide surface **61** in the direction of the virtual line **57**.

Further, as shown in FIGS. **4** and **5**, a first projecting amount by which a downstream end in the discharging direction of the projection **24***c* projects to the placing surface **31***a* side relative to the nip **51** is greater than a second projecting amount by which a downstream end in the discharging direction of the projection **24***a* projects to the placing surface **31***a* side relative to the nip **51**. The first projecting amount is, for example, defined as a distance from the discharge plane **56** to a downstream end of the guide surface **62** in the direction of the virtual line **57**. The second projecting amount is, for example, defined as a distance from the discharge plane **56** to a downstream end of the guide surface **61** in the direction of the virtual line **57**.

Next, a configuration in the vicinity of the nip **52** will be described with reference to FIG. **6** showing a cross-section at the roller facing portion at which the roller portion **22***b* of the first discharge roller **22** and the roller portion **23***b* of the second discharge roller **23** form the nip **52**.

In FIG. **6**, the dashed-dotted line in the direction of arrow F indicates the virtual line **57**, and the dashed-dotted line in the direction of arrow G indicates the discharge plane **56**. Referring to FIG. **3**, the discharge guide **24** does not exist in the vicinity of the roller facing portion. As shown in FIG. **6**, on the upstream side of the nip **52** in the conveying direction, the guide surface **33** forms the conveying path with a guide surface **34** of the guide portion **81** of the main body **80** so as to extend to the vicinity of the nip **52**.

The leading edge of the recording sheet **40** conveyed from below in the direction of arrow H is guided by the guide surfaces **33** and **34** along the conveying path, and then becomes free (or unguided) near the nip **52**. Meanwhile, as described above, the leading edge of the recording sheet **40** is guided below the discharge plane **56** by the projections **24***a* to **24***e* of the discharge guide **24**. Thus, the leading edge of the recording sheet **40** moves in abutment on the lower guide surface **33** or the roller portion **22***b* of the first discharge roller **22** to the nip **52**.

A configuration in the vicinity of the nip **51** is the same as that in the vicinity of the nip **52**, and the description thereof will be omitted.

An operation of the above described medium discharge device **70** will be described below.

Referring to FIG. **1**, the fixing unit **28** performs fixing processing on a recording sheet **40**, which is conveyed through a conveying path **21** shown in FIG. **2**. Referring to FIGS. **4** and **5**, the recording sheet **40** is conveyed in the direction of arrow H, and then the leading edge of the recording sheet **40** abuts on and is guided by the inlet surfaces **61***a* and **62***a* (having the same cross-sectional shape) of the projections **24***a* to **24***e* of the discharge guide **24** toward the nips **51** and **52**.

At this time, as shown in FIGS. **4** and **5**, when viewed from the Y-axis direction, the recording sheet **40** is maintained generally below the discharge plane **56** (on the first roller **22** side) by the inlet surfaces **61***a* and **62***a* of the projections **24***a* to **24***e*, and guided so as to separate from the discharge plane **56** as approaching the nips **51** and **52**, protruding downward (to the first roller **22** side) by a predetermined amount relative to the nips **51** and **52** at the position on the virtual line **57**.

FIG. **3** shows a sheet cross-section **40***a* of the recording sheet **40** at the position of the nips **51** and **52** with the dashed line. As shown in FIG. **3**, when the recording sheet **40** is nipped in the nips **51** and **52**, it protrudes to the first discharge roller **22** side from the discharge plane **56** between the nips **51** and **52** by the projections **24***b*, **24***c*, and **24***d*, on the outer side of the nip **51** by the projection **24***a*, and on the outer side of the nip **52** by the projection **24***e*. Thus, the recording sheet **40** is bent to have a wave-shaped cross-section.

When the recording sheet **40** is conveyed toward the nips **51** and **52** while guided by the inlet surfaces **61***a* and **62***a* of the projections **24***a* to **24***e* and the roller portions **22***a* and **22***b* of the first discharge roller **22**, until it reaches the nips **51** and **52**, it is freely deformable. Thus, the recording sheet **40** can be bent so that its cross-section **40***a* at the position of the nips **51** and **52** becomes into a wavy shape, without a load due to expansion and contraction of the recording sheet **40**.

On the other hand, on the downstream side of the nips **51** and **52**, the recording sheet **40** moves while nipped in the nips **51** and **52**. Thus, it is undesirable that the projections **24***a*, **24***b*, **24***d*, and **24***e*, which are disposed near the nips **51** and **52**, guide the recording sheet **40** to forcibly deform the shape of the sheet cross-section **40***a* at the position of the nips **51** and **52** (e.g., increase the protrusion of the recording sheet **40**). If the projections **24***a*, **24***b*, **24***d*, and **24***e* were to guide the recording sheet **40** to forcibly deform the shape of the sheet cross-section **40***a* on the downstream side of and in the vicinity of the nips **51** and **52**, the recording sheet **40** would be subjected to excessive stress, which causing wrinkles and flaws on the recording sheet **40**.

Thus, regarding the projections **24***a*, **24***b*, **24***d*, and **24***e*, as shown in FIG. **4**, the outlet surface **61***b* on the downstream side of the nips **51** and **52** is formed to approach the discharge plane **56** as it extends downstream, or parallel to the discharge plane **56**. It is noted that since the outlet surface **61***b* extends downstream continuously to the inlet surface **61***a*, the leading edge of the recording sheet is prevented from, immediately after passing through the nips **51** and **52**, suddenly becoming free to contact a member near the discharge rollers **22** and **23** and being damaged.

On the other hand, regarding the projection **24***c*, which is disposed relatively away from the nips **51** and **52** between the projections **24***b* and **24***d* (and also between the nips **51** and **52**), as shown in FIG. **5**, the outlet surface **62***b* on the downstream side of the nips **51** and **52** is curved to separate from the discharge plane **56** as it extends downstream, pressing the recording sheet **40** to prevent slack of the recording sheet **40** on the downstream side of the nips **51** and **52** and maintain proper tension of the recording sheet **40** uniformly in the left-right direction (the Y-axis direction).

Thus, the recording sheet **40** is discharged from the nips **51** and **52** along the discharge plane **56** obliquely upward in the direction of arrow G (FIG. **2**) in a state where the sheet cross-section **40***a* is deformed in a wave shape. This wave shape of the sheet cross-section **40***a* has, as shown in FIG. **3**, three concave/convex portions (specifically, one concave portion and two convex portions), which increase the stiffness of the recording sheet **40**. Therefore, the recording sheet **40** is discharged and falls onto the discharge tray **31** while maintaining a state where its leading edge is difficult to sag due to its own weight. The term "concave/convex portion" means a portion forming either a concave or a convex.

The discharged recording sheet **40** is received and held on the placing surface **31***a* of the discharge tray **31**. The placing surface **31***a* faces upward, and here extends parallel to the discharge plane **56**. The guide surfaces **61** and **62** of the discharge guide **24** are disposed generally along the discharge plane **56** to face downward, therefore opposing the placing surface **31***a* vertically (more accurately, in the direction of the virtual line **57**).

FIG. **8** is a sectional view of a medium discharge device as a comparative example, which is the same as the medium discharge device **70** except for having a discharge guide **224** different in shape from the discharge guide **24** in the embodiment.

As shown in FIG. **8**, between the nips **51** and **52**, the discharge guide **224** presses down the recording sheet **40** below the discharge plane **56** to form a protrusion in the recording sheet **40**, similarly to the discharge guide **24** of the embodiment. However, on the outer side of the nip **51** and the outer side of the nip **52**, the projections **224***a* and **224***e* do not press the recording sheet **40** down, and form no protrusion in the recording sheet **40**. Thus, although the recording sheet **40** is discharged from the nips **51** and **52** along the discharge plane **56** obliquely upward in the direction of arrow G (FIG. **2**) in a state where the sheet cross-section **40***a* is deformed in a wave shape in the width direction, the wave shape of the sheet cross-section **40***a* has only one concave/convex portion (specifically, only one concave portion), as shown in FIG. **8**.

Thus, in the comparative example, compared to the embodiment, the discharged recording sheet **40** has a low stiffness and is easy to sag during discharging or falling onto the discharge tray **31**, and improper discharge, such as page disorder, page missing, and sheet curl, is likely to occur. The stiffness of the recording sheet **40** in the comparative example can be increased by making the protrusion higher or closer to the nips **51** and **52**. However, this increases a load on the recording sheet **40** due to deformation, causing flaws or wrinkles on the recording sheet **40**.

As described above, the medium discharge device in this embodiment discharges the recording sheet while increasing the stiffness of the recording sheet by deforming the recording sheet in a wave surface shape to form multiple concave/convex portions, thereby reducing improper discharge (or improper stacking), such as page disorder, page missing, and sheet curl, even if the distance by which the recording sheet falls down to the placing surface is large. Further, the medium discharge device in this embodiment can reduce the occurrence of flaws, wrinkles, or the like caused by making the protrusion higher or wider.

Although in this embodiment, the projection **24***b* is disposed between the projection **24***c* and the nip **51** and the projection **24***d* is disposed between the projection **24***c* and the nip **52**, either or both of the projections **24***b* and **24***d* may be omitted. Even in such a case, three concave/convex portions are formed in the wave surface of the discharged recording sheet, and advantages similar to those described above can be obtained. In this case, it is desirable to set the width of the projection **24***c* or the shape of the outlet surface **62***b* of the projection **24***c* so as to reduce the slack of the recording sheet **40** on the downstream side of the nips **51** and **52**.

Further, although in this embodiment, the projection **24***a* is disposed on the end side of the nip **51** and the projection **24***e* is disposed on the end side of the nip **52**, either the projection **24***a* or **24***e* may be omitted. Even in such a case, compared to the comparative example, the number of concave/convex portions in the wave surface of the discharged recording sheet increases, and the stiffness of the discharged recording sheet is strengthened.

Second Embodiment

An image forming apparatus in the second embodiment will be described below. This image forming apparatus is substantially the same as in the first embodiment, except for including a medium discharge device different from that in the first embodiment. Thus, descriptions of parts that are the same as in the first embodiment will be omitted or simplified in the description below, and the same reference characters will be used.

FIG. **7** is a main part sectional view of the medium discharge device in the second embodiment. FIG. **7** corresponds to the sectional view along line A-A in FIG. **2**, similarly to FIG. **3** in the first embodiment.

The medium discharge device in the second embodiment includes a discharge guide **124** corresponding to the discharge guide **24** in the first embodiment. The discharge guide **124** includes guide projections **124***a* to **124***e* corresponding to the projections **24***a* to **24***e* in the first embodiment. The guide projections **124***a* to **124***e* are disposed slidably in a direction perpendicular to the discharge plane **56**, and urged toward the placing surface **31***a*. The guide projections **124***a* to **124***e* are disposed separately from each other, and individually urged by respective coil springs **110***a* to **110***e* as urging members.

As shown in FIG. **7**, the image forming apparatus includes guide holding holes **120***a* to **120***e* formed in a main body **180** of the image forming apparatus. The guide projections **124***a* to **124***e* are inserted and held in the guide holding holes **120***a* to **120***e* slidably in the direction of the virtual line **57**, respectively. The guide projections **124***a* to **124***e* have restricting portions (or flange portions) **190***a* to **190***e*, respectively. The restricting portions **190***a* to **190***e* abut on the main body **180** at parts around the guide holding holes **120***a* to **120***e*, thereby restricting the guide projections **124***a* to **124***e* from moving in a projecting direction opposite to arrow F from their normal positions, respectively. When the guide projections **124***a* to **124***e* are in their normal positions, they are pressed against the main body **180** by the coil springs **110***a* to **110***e* in the projecting direction.

Each of the guide projections **124***a*, **124***b*, **124***d*, and **124***e* is configured to have, in its normal position, a guide surface identical to the guide surface **61** of the projection **24***a* in FIG. **4**, and a relationship between the guide surface and the nips **51** and **52** identical to the relationship between the guide surface **61** and the nips **51** and **52** in FIG. **4**.

The guide projection **124***c* is configured to have, in its normal position, a guide surface identical to the guide surface **62** of the projection **24***c* in FIG. **5**, and a relationship between the guide surface and the nips **51** and **52** identical to the relationship between the guide surface **62** and the nips **51** and **52** in FIG. **5**.

Therefore, when the guide projections **124***a* to **124***e* are in their normal positions, the recording sheet **40** is discharged through the nips **51** and **52** along the discharge plane **56** obliquely upward in the direction of arrow G (FIG. **2**) in a state where the sheet cross-section **40***a* is deformed in a wave shape, in the same manner as the first embodiment.

In this embodiment, the guide projections **124***a* to **124***e* are slidably urged by the respective coil springs **110***a* to **110***e*. Thus, when the recording sheet **40** is discharged, depending on the stiffness of the recording sheet **40** itself, each of the guide projections **124***a* to **124***e* moves in a retreating direction opposite to the projecting direction to vary its height from the discharge plane **56** in the projecting direction, thereby adjusting a degree of increase of the stiffness. Specifically, the height of the guide projection **124***a* is at its maximum when the guide projection **124***a* is in its normal position, and decreases as the guide projection **124***a* moving in the retreating direction from its normal position. The normal position is also referred to as the maximum height position. The same is true for the other guide projections **124***b* to **124***e*. When the guide projections **124***a* to **124***e* are in their normal positions, they bend the recording sheet **40** maximally. That is, when the recording sheet **40** is guided by the guide projections **124***a* to **124***e* in their normal positions, the recording sheet **40** is discharged in a maximum bending state where it is maximally bent.

More specifically, when the recording sheet is a thin paper sheet with low stiffness, since its leading edge is easy to sag during discharge, its stiffness needs to be increased. When the recording sheet with low stiffness is discharged, since the coil springs **110***a* to **110***e* do not deform and the guide projections **124***a* to **124***e* stay in their normal positions (maximum height positions), the recording sheet is discharged in a state where it is maximally bent and its stiffness is maximally increased. In this case, although the recording sheet is maximally bent, since the stiffness of the recording sheet itself is low, flaws and wrinkles are difficult to occur.

On the other hand, when the recording sheet is a thick paper sheet with high stiffness, since its leading edge is difficult to sag during discharge, its stiffness does not need to be increased much. When the recording sheet with high stiffness is discharged, the recording sheet presses the guide projections **124***a* to **124***e* down in the retreating direction from their normal positions (maximum height positions) against the urging force of the coil springs **110***a* to **110***e*, lowering the heights of the guide projections **124***a* to **124***e*. Therefore, the recording sheet is discharged in a state where it is less bent. If the recording sheet with high stiffness were to be forcibly bent, flaws and wrinkles would occur. The configuration of this embodiment can prevent such problems.

Although in this embodiment, the guide projections **124***a* to **124***e* are formed separately from each other and individually urged by the coil springs, the guide projections **124***a* to **124***e* may be formed integrally, and the whole of the guide projections **124***a* to **124***e* may be urged by only one coil spring or urging member, for example.

As described above, the medium discharge device in this embodiment adjusts the amount of bending of the recording sheet depending on the stiffness of the recording sheet so that the higher the stiffness, the smaller the amount of bending, and prevents a recording sheet with high stiffness (e.g., a thick paper sheet) from being bent more than necessary. Thus, this embodiment can provide the same advantages as in the first embodiment without causing flaws and wrinkles on the recording sheet.

In this specification, the term "parallel" is intended to include not only completely parallel but also substantially parallel, and the term "perpendicular" is intended to include not only completely perpendicular but also substantially perpendicular.

While the preferred embodiments of the present invention have been illustrated in detail, it should be apparent that modifications and improvements may be made to the invention without departing from the spirit and scope of the invention as described in the following claims.

For example, although in the above embodiments, the LED head is used as an exposure unit of the image forming apparatus, a laser exposure unit including a small-sized laser and a polygon mirror may be used. Further, although the above embodiments illustrate an image forming apparatus using a direct transfer system, the invention is applicable to an image forming apparatus using an intermediate transfer belt. Furthermore, the above embodiments exemplify a printer as an image forming apparatus, but the invention is applicable to a copier, a facsimile machine, or other image forming apparatus.

What is claimed is:

1. A medium discharge device comprising:

a discharge tray having a placing surface on which a medium is to be placed;

a first pair of discharge rollers configured to form a first nip between the first pair of discharge rollers, and rotate about respective axes parallel to each other to discharge the medium through the first nip in a discharging direction onto the discharge tray;

a second pair of discharge rollers configured to form a second nip between the second pair of discharge rollers, and rotate about the respective axes to discharge the medium through the second nip in the discharging direction onto the discharge tray; and

a discharge guide for guiding the medium discharged by the first pair of discharge rollers and the second pair of discharge rollers, the discharge guide including:

a first projection disposed between the first pair of discharge rollers and the second pair of discharge rollers in an axial direction parallel to the axes, the first projection projecting toward the placing surface relative to the first and second nips and having a first guide surface; and

a second projection disposed on an opposite side of the first projection with respect to the first pair of discharge rollers in the axial direction, the second projection projecting toward the placing surface relative to the first and second nips and having a second guide surface;

wherein each of the first and second guide surfaces extends from an upstream side to a downstream side of the first and second nips in the discharging direction; and

wherein on the downstream side of the first and second nips, the first guide surface has an area inclined to a discharge plane passing through the first and second nips and being perpendicular to a virtual line perpendicularly intersecting the axes so as to separate from the discharge plane downstream in the discharging direction;

wherein on the downstream side of the first and second nips, the second guide surface is parallel to the discharge plane, or is inclined to the discharge plane so as to approach the discharge plane downstream in the discharging direction.

2. The medium discharge device of claim **1**, wherein a difference between a projecting amount by which the first projection projects toward the placing surface relative to the first nip and a projecting amount by which the second projection projects toward the placing surface relative to the first nip increases downstream from the first nip in the discharging direction.

3. The medium discharge device of claim **1**, wherein a first projecting amount by which a downstream end in the discharging direction of the first projection projects toward the placing surface relative to the first nip is greater than a second projecting amount by which a downstream end in the discharging direction of the second projection projects toward the placing surface relative to the first nip.

4. The medium discharge device of claim **1**, wherein the discharge guide further includes a third projection disposed on an opposite side of the first projection with respect to the second pair of discharge rollers in the axial direction, the third projection projecting toward the placing surface relative to the first and second nips and having a third guide surface.

5. The medium discharge device of claim **4**, wherein the discharge guide further includes:

a fourth projection disposed between the first projection and the first pair of discharge rollers in the axial direction, the fourth projection projecting toward the placing surface relative to the first and second nips and having a fourth guide surface; and

a fifth projection disposed between the first projection and the second pair of discharge rollers in the axial direction, the fifth projection projecting toward the placing surface relative to the first and second nips and having a fifth guide surface.

6. The medium discharge device of claim **5**, wherein each of the third to fifth guide surfaces extends from an upstream side to a downstream side of the first and second nips in the discharging direction.

7. The medium discharge device of claim **6**, wherein on the downstream side of the first and second nips, each of the third to fifth guide surfaces is parallel to the discharge plane, or is inclined to the discharge plane so as to approach the discharge plane downstream in the discharging direction.

8. An image forming apparatus comprising the medium discharge device of claim **1**.

9. A medium discharge device comprising:

a discharge tray having a placing surface on which a medium is to be placed;

a first pair of discharge rollers configured to form a first nip between the first pair of discharge rollers, and rotate about respective axes parallel to each other to discharge the medium through the first nip in a discharging direction onto the discharge tray;

a second pair of discharge rollers configured to form a second nip between the second pair of discharge rollers, and rotate about the respective axes to discharge the medium through the second nip in the discharging direction onto the discharge tray; and

a discharge guide for guiding the medium discharged by the first pair of discharge rollers and the second pair of discharge rollers, the discharge guide including;

a first projection disposed between the first pair of discharge rollers and the second pair of discharge rollers in an axial direction parallel to the axes, the first projection projecting toward the placing surface relative to the first and second nips and having a first guide surface; and

a second projection disposed on an opposite side of the first projection with respect to the first pair of discharge rollers in the axial direction, the second projection projecting toward the placing surface relative to the first and second nips and having a second guide surface;

wherein the first and second projections are disposed slidably in a direction in which a virtual line perpendicularly intersecting the axes extends, and urged toward the placing surface.

10. The medium discharge device of claim **9**, wherein the first and second projections are formed separately from each other and individually urged.

11. The medium discharge device of claim **9**, wherein each of the first and second guide surfaces extends from an upstream side to a downstream side of the first and second nips in the discharging direction.

12. The medium discharge device of claim **11**, wherein on the downstream side of the first and second nips, the second guide surface is parallel to a discharge plane passing through the first and second nips and being perpendicular to the virtual line, or is inclined to the discharge plane so as to approach the discharge plane downstream in the discharging direction.

13. The medium discharge device of claim **11**, wherein on the downstream side of the first and second nips, the first guide surface has an area inclined to a discharge plane passing through the first and second nips and being perpendicular to the virtual line so as to separate from the discharge plane downstream in the discharging direction.

14. An image forming apparatus comprising the medium discharge device of claim **9**.

15. A medium discharge device comprising:

a discharge tray having a placing surface on which a medium is to be placed;

a first pair of discharge rollers including a first roller that rotates about a first axis extending in a first direction and a second roller that rotates about a second axis extending in the first direction, the first roller and the second roller forming a first nip between the first roller and the second roller, the first pair of discharge rollers discharging the medium through the first nip onto the discharge tray;

a second pair of discharge rollers including a third roller that rotates about the first axis and a fourth roller that rotates about the second axis, the third roller and the fourth roller forming a second nip between the third roller and the fourth roller, the second pair of discharge rollers discharging the medium through the second nip onto the discharge tray; and

a discharge guide configured to guide the medium discharged by the first pair of discharge rollers and the second pair of discharge rollers, the discharge guide including a plurality of projections including at least a first projection and a second projection;

wherein the first projection is disposed between the first pair of discharge rollers and the second pair of discharge rollers in the first direction, projects in a second direction in which a virtual line perpendicularly intersecting both the first axis and the second axis extends toward the placing surface, and has a first guide surface;

wherein of the plurality of projections, the second projection is located farthest from a center of the discharge guide on an opposite side of the first projection with respect to the first pair of discharge rollers in the first direction, projects in the second direction, and has a second guide surface;

wherein in a plane parallel to and including both the first axis and the second axis, a distance between the first guide surface and the placing surface is smaller than a distance between the first nip and the placing surface, and a distance between the second guide surface and the placing surface is smaller than a distance between the first nip and the placing surface;

wherein each of the first and second guide surfaces extends from an upstream side to a downstream side of the first nip in a discharging direction in which the medium is discharged; and

wherein on the downstream side of the first nip, the first guide surface has an area inclined to a discharge plane passing through the first nip and being perpendicular to the virtual line so as to separate from the discharge plane downstream in the discharging direction; and

wherein on the downstream side of the first nip, the second guide surface is parallel to a discharge plane passing through the first nip and being perpendicular to the virtual line, or is inclined to the discharge plane so as to approach the discharge plane downstream in the discharging direction.

16. An image forming apparatus comprising the medium discharge device of claim **15**.

17. A medium discharge device comprising:

a discharge tray having a placing surface on which a medium is to be placed;

a pair of discharge rollers including a first roller that rotates about a first axis extending in a first direction and a second roller that rotates about a second axis extending in the first direction, the first roller and the second roller forming a nip between the first roller and the second roller, the pair of discharge rollers discharging the medium through the nip onto the discharge tray; and

a discharge guide configured to guide the medium discharged by the pair of discharge rollers, the discharge guide including:

a first projection that projects in a second direction in which a virtual line perpendicularly intersecting both the first axis and the second axis extends toward the placing surface, and has a first guide surface; and

a second projection that projects in the second direction, and has a second guide surface;

wherein in a plane parallel to and including both the first axis and the second axis, a distance between the first guide surface and the placing surface is smaller than a distance between the nip and the placing surface, and a distance between the second guide surface and the placing surface is smaller than a distance between the nip and the placing surface; and

wherein in the first direction, a length of the first guide surface is greater than a length of the second guide surface.

18. The medium discharge device of claim **17**, wherein the pair of discharging rollers is disposed between the first projection and the second projection in the first direction; and

wherein each of the first and second guide surfaces extends from an upstream side to a downstream side of the nip in a discharging direction in which the medium is discharged.

19. The medium discharge device of claim **18**, wherein on the downstream side of the nip, the second guide surface is parallel to a discharge plane passing through the nip and being perpendicular to the virtual line, or is inclined to the discharge plane so as to approach the discharge plane downstream in the discharging direction.

20. The medium discharge device of claim **18**, wherein on the downstream side of the nip, the first guide surface has an area inclined to a discharge plane passing through the nip and being perpendicular to the virtual line so as to separate from the discharge plane downstream in the discharging direction.

21. An image forming apparatus comprising the medium discharge device of claim **17**.

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